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TRAINING AND RESEARCH PROGRAM IN COMPUTER APPLICATIONS.

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TO MAKE EDUCATIONAL RESEARCHERS AND TEACHERS MORE AWARE OF THE VALUES OF ELECTRONIC AUTOMATION, THIS ARTICLE PROPOSES A TRAINING-RESEARCH PROGRAM USING THE IBM 360/67 AND THE IBM 1500 COMPUTERS. PARTICIPANTS WOULD BE SELECTED FROM (1) POST-DOCTORAL AND PROFESSIONAL UNIVERSITY STAFF MEMBERS ON SABBATICAL LEAVE WHOSE MAIN INTEREST IS EDUCATIONAL RESEARCH, (2) GRADUATE STUDENTS STUDYING TOWARD A MASTER'S OR DOCTORAL DEGREE, AND (3) PRACTICING TEACHERS WHO MAY OR MAY NOT BE IN CATEGORIES 1 OR 2. DURING THE ACADEMIC TERM AT ALBERTA UNIVERSITY, COURSE WORK WOULD CONSIST OF (A) SEMINARS--6 HOURS PER WEEK FOR 4 MONTHS TO INTRODUCE THE TRAINEE TO FORTRAN IV AND APL COMPUTER LANGUAGES, (B) 2 MONTHS OF INSTRUCTION IN THE USE OF THE IBM 1500 INCLUDING PROGRAMMING A NUMBER OF SMALL TEACHING PROGRAMS AND (C) 4 MONTHS OF WORKING ON COMPUTER PROGRAMS RELEVANT TO THE TRAINEES' RESEARCH INTEREST. DURING THE SUMMER PARTICIPANTS WOULD BE INTRODUCED TO THE COURSE-WRITER II AND THE APL LANGUAGES AND ASSISTED IN PREPARING TEACHING PROGRAMS IN THEIR SUBJECT SPECIALTY. POST-DOCTORAL STUDENTS WOULD BE REQUIRED TO REVIEW AND REPORT ON RESEARCH PAPERS RELATED TO COMPUTER APPLICATIONS IN THEIR AREA OF INTEREST. (AW)

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PROJECT DETAILS

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Identification of the Problem

During the last decade, and particularly during the last two years, electronic automation has entered almost every sphere of human endeavour. Chemical processing companies have automated complete factories and industrial fabricating firms have turned over much of their stamping, drilling, and milling operations to electronic control systems. Service industries within the last ten years have studied queing problems in sufficient depth to produce the familiar electronic reservation systems. Where industrial or service units are widely dispersed geographically, vast and complex information transmission systems have facilitated the development of other systems such as are exemplified by the automated library. More recently publishing houses have been automating their type-setting operations and contributing directly to the production of low cost reading material. It is estimated that in Canada alone 900 computing 'units' exist, and that by 1970 an additional 2400 'units' will be in operation.

A large proportion of Canada's computing power has been centered in institutions of higher learning, principally in the major universities in the provinces. The largest contributor to the development of such facilities has been the Canadian National Research Council. The facilities have contributed not only to the basic scientific research in the physical sciences but also to the development of data systems useful to industry in general. Of equal importance, the same developments have also provided for the training of numerical analysts and programmers for the maintenance of computing systems.

The use of electronic equipment to facilitate and increase industrial and scientific productivity has not been effected without a certain amount of distortion in the 'life space' of the members of our society. In some occupations the reaction to this distortion has hardly been perceptible, in others quite violent. It is more than a coincidence that the greatest reaction against automation has come from sections of our society which have existed for long periods of time, where job specifications have become highly 'humanized', (rightly or wrongly through persistent repetition that only humans can do the job), and where special organizations have grown up not only to maintain and create an occupational mystique, but also to control the entrance of new members. Newly created work forces whose productivity is integrated with electronic control systems have not reacted violently against such systems.

One important segment of our society has, because of the nature of its activity, remained relatively immune to the effects of electronic automation even though its services are vitally related to work productivity in Canada. The teaching force in Canada has not been affected to the same extent as other productive forces because very complex technical developments are required to substitute for even the most pedestrian tasks required in the teaching act. This immunity cannot persist since, for example, optical reading equipment to score examination papers and complete computing systems to provide the interface between the student and the knowledge to be studied are already being produced. At present we are fortunate in that there is still time to introduce the concepts and applications in automation to researchers and teachers through the educational training institutions. Such introduction can lessen to some degree the negative and delaying reactions usually accompanying the introduction of automation. Time is short, however, since a large number of electronics, educational materials, and mass media firms have already merged. It is to be expected that the results of

such mergers will be the production of highly complex electronic educational environments. In the past we have always erred by underestimating the effectiveness and universal applicability of such systems. If the training of teachers and educational researchers does not encompass the concepts of automation, serious difficulties can be expected by society in meeting the demands required to educate the public at all age levels. In addition, the general resistance towards electronic automation by an unprepared teaching force could delay for a considerable time the acceptance and use of the most beneficial aspects of automation in the educational field.

Our main objective, therefore, is to bring the concepts of electronic automation down to the level of the educational researchers and practising teacher so that the technological developments may be wisely and judiciously applied to enhance their teaching and research environments. The need for training educational researchers to make effective use of electronic equipment is long overdue.

A survey of the directors of computing centers in all the major Canadian universities conducted 18 months ago revealed a serious problem concerning the use of computers by educational researchers (and social science researchers in general). It was found that the educational researchers used, on the average, about 1-1/2 hours of computer time per month--roughly equated to IBM 7040 time. This very low rate of usage becomes even more disturbing in the light of the derogatory remarks made by the directors about educational and social science researchers. The majority of the comments are of the following types:

a) -the researchers should learn how to use existing computer programs without depending completely upon the staff members of the computing center;

b) -the researchers lack any technical experience in this area;

c) -there is a mutual ignorance of problems and a lack of effective communication;

d) -researchers are not willing to take responsibility for the preparation of their data or for learning, even in general terms, how the computer functions;

e) -there is a general apathy of researchers to solve problems using the computer.

Our experience during the last three years at the University of Alberta indicates that such a situation as described by these comments need not exist.

The Training and Research Program

In the light of the serious shortcomings of most educational researchers to make adequate use of computing facilities and the almost complete lack of experience by teachers in the use and understanding of present automatic electronic equipment, we propose a training-research program designed to remove these deficiencies. We propose further that, in terms of automatic equipment, two types of general computing systems be introduced to the participants: a) the general purpose digital computer (IBM 360/67 time-sharing), and b) the computer-assisted instruction system (IBM 1500).

It is our intention to introduce the participants to both the general purpose and teaching computer, but they will be permitted to familiarize themselves to a greater degree with one of the systems if they so desire. Specific objectives to be attained by trainees relative to the area of general purpose digital computers, would be as follows:

a) -to be able to communicate effectively with programmers, analysts, and operators of computing centers;

b) -to be able to make use of existing computer programs;

c) -to learn the use of both Fortran and APL[1] languages in the context of educational research problems such as, for example, storage of student records, statistical analysis, analysis of examination results, etc.;

d) -to use the digital computer as an effective tool in their own special area of interest;

e) -to be familiar with the most commonly used research design problems in education;

f) -to be able to assist colleagues and graduate students to organize research data in a form amenable to computer analysis.

Specific objectives to be attained by trainees in the area of computerized teaching systems would be:

a) -to be able to assess the potential and limitations of automated teaching environments;

b) -to be able to use as a tool the two most common languages used in computerized teaching systems, i.e., Coursewriter II and APL.

c) -to be able to assist other subject-matter specialists to make use of such teaching systems;

d) -to be able to make effective use of a computerized teaching system in his own subject matter area.

Computer programs which already exist, and those which will be developed in the program, will be made available to participants. Assistance will also be given to the participants in terms of pointing out the modifications which may be required to adapt these programs to the machines available to them. Documentation of all programs will also be made and maintained for general distribution. Once this service is started it is hoped that in future it would be part of the service offered through the Division of Educational Research Services.

Participants

Three categories of participants would be invited to apply:

a) -post-doctoral and professional university staff members on sabbatical leave, having as their main area of interest educational research in its broadest sense;

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[1]APL is the abbreviation of K. E. Iverson's powerful computer language. It is fully described in the text entitled A Programming Language, by K. E. Iverson, Wiley, 1962. This language has already been adapted to the IBM 7040 at the University of Alberta.

b) -graduate students studying towards a master's or doctoral degree;

c) -practising teachers who may or may not be in categories (a) or (b) above.

Approval of trainees would require their acceptance by the appropriate Faculty and Department within the University of Alberta.

Our purpose for selecting post-doctoral candidates is to provide them with specialized training over and above their academic speciality. For example, a Ph. D. trained in educational administration could now become familiar with computing systems as they relate to school scheduling, time-tabling, storing of student records, and administrative decision making. In addition, his ability to answer research problems requiring computer analysis would also be greatly improved. Professional staff on sabbatical leave would, in effect, be engaging in an up-dating program of the same type as post-doctoral candidates. Students in category (b) would still be able to obtain their graduate degrees in specialized areas of education which have already been established within the Faculty of Education. They would be expected to take a reduced course load and thus to participate in special seminars covering both types of computing systems. Teachers would attend special seminars during the summer months and concentrate on the use of the teaching computer.

Course Content

Post-doctoral candidates and graduate students will participate in the same seminars during the academic term. The seminars would take approximately six hours per week during the first four months and would introduce the trainees to Fortran IV and APL. Although the students will be expected to write a number of small Fortran problems to solve simple problems frequently encountered in educational research, stress will be given to the construction and integrated use of subroutines. APL will be taught so that the students would be able to use the IBM 360 and IBM 1500 as they would normally use the desk calculator. Our experience has shown that students with very limited mathematical training can successfully apply this language to simple problems after very little formal training. The use of APL would also provide the initial success so important to students beginning computer work. It will also be used to eliminate the need for checking calculations on a desk calculator. During the following two months the trainees would be introduced to the IBM 1500 system. The introduction would be facilitated by APL as a language common to both machines. Trainees would also be required to learn Coursewriter II and program a number of small teaching programs using the full audio, visual, and light pencil capabilities of the IBM 1500. During the last four months students would work on computing problems relevant to their research interests. During the time computer training is being given, post-doctoral students will be required to review and report upon research papers related to computer applications in their area of interest, while graduate students will be expected to complete their academic course requirements.

Teachers participating during the summer will be introduced to the Coursewriter II and APL languages and assisted to prepare teaching programs in their subject speciality. Resources are to be provided to permit the full use of the IBM 1500 capabilities.

During the latter portion of each program visiting professors working in the area of computer applications to educational research and teaching, will be invited to address the students.

Evaluation of the Program

The immediate success of the program could be judged by the skill with which trainees are able to handle the most frequently encountered computer processing problems. This could be judged by the programs and research papers which are produced during the latter part of the program. The ultimate success of the program could also be judged by assessing the degree to which a computing system is used by the trainee after completing our program. Such information could be obtained from the computing center available to the trainee. It would also be expected that new computer programs, research activities, and specialized courses would be developed by trainees in the institutions to which they return.

The effectiveness of the program for teachers could be judged by the extent to which the teachers continue their activities with computer-assisted instruction. The teachers will be permitted to use the system during the winter months with their own school classes.

The University of Alberta as Host for the Program

We feel that the University of Alberta is an ideal location for establishing such a modern training and research program. Several reasons exist for this opinion:

(a) The Faculty of Education is the only faculty having a Division of Educational Research Services whose resources are devoted solely to facilitating educational research of graduate students and staff members. It depends upon no direct financial support from the government nor does it do any work for them. The resources for the Division come directly through the university budget.

(b) The Division of Educational Research Services has an excellent relationship with the Department of Computing Science and the Computing Centre.

(c) The Department of Computing Science has joint appointments with the Department of Psychology and the Division of Educational Research Services. It has also one expert in the field of computer-assisted instruction.

(d) The University of Alberta expects delivery of the IBM 360/67 time-sharing computer in the summer of 1967. A satellite is to be installed in the Education Building.

(e) The University expects delivery of an IBM 1500 teaching computer system in April of 1967. It will be one of only two such systems allocated to Canada. This system will be housed in the Education Building.

(f) The Division of Educational Research Services in cooperation with other departments in the Faculty is already conducting seminars in research design and the use of the digital computer. Approximately 100 students are involved.

(g) The Division maintains peripheral IBM equipment for preparation of data cards and computer programs. This equipment includes optical reading equipment.

(h) The Division has developed a computer program library. This library has been requested by both Canadian and American social science researchers. The library has been developed with the assistance of three part-time graduate students completing their doctorates in educational psychology. The work was carried out under the supervision of the Director of Educational Research.

Through the Divison of Educational Research Services, the staff members and graduate students have been acquainted with the general purpose digital computer. An average of approximately 50 hours per month of IBM 7040 computer time is used by the Faculty of Education. The Faculty is the fourth largest user of the computing facility in terms of time, and the third largest in terms of the number of problems submitted for analysis. Staff members and graduate students of every department are assisted in using the computing facility. Undergraduate student projects in examination construction are also handled each year. The latter also make use of automatic electronic scoring equipment.

We feel confident that no other Faculty of Education in Canada has made such extensive use of computers for purposes of educational research.

Personnel for the Project

Director: Stephen M. Hunka, Associate Professor of Educational Psychology, received the Ph. D. degree from the University of Illinois in 1961 specializing in educational measurement and psychology. He was a research assistant to Dr. H. F. Kaiser at the Bureau of Educational Research, having as his main duties programming for the Illiac Computer. He is at present Director of the Division of Educational Research Services at the University of Alberta and conducts courses in the application of numerical and statistical models to Educational Research. He also holds joint appointments in the Departments of Medicine and Computing Science. He has published in the Review of Educational Research, Harvard Educational Review, Psychological Reports, Mental Measurements Yearbook, Journal of the Canadian Medical Association, The Journal of Medical Education, The Journal of Administration, and Supervision, and is co-author of the book, Cognitive Processes (Prentic-Hall, 1964).

Project Staff: It is anticipated that one or two staff members other than the Director would work with the students in the seminar sessions. It is possible that students now completing their Ph. D.'s under the director would be available. One of these students who has worked with the Division for two years, has an excellent background in physics and mathematics. He has a B. Sc. in engineering-physics, an M. Sc. in theoretical phsyics, and should be completing the Ph. D. in Educational Psychology in 1967. A second student, fully

familiar with the research needs of educational researchers, and well versed in computer technology, will also be completing the Ph. D. very shortly. If both students are available, part of their salaries may well be picked up by one of the existing departments within the Faculty. A third possibility exists in that one member of the Department of Computing Science has experience in computer-assisted instruction. This person has a Ph. D. in Computing Science and has spent one year at Science Research Associates in Chicago. Science Research Associates are affiliated with IBM and carryout much of the educational research related to computer-assisted instruction.